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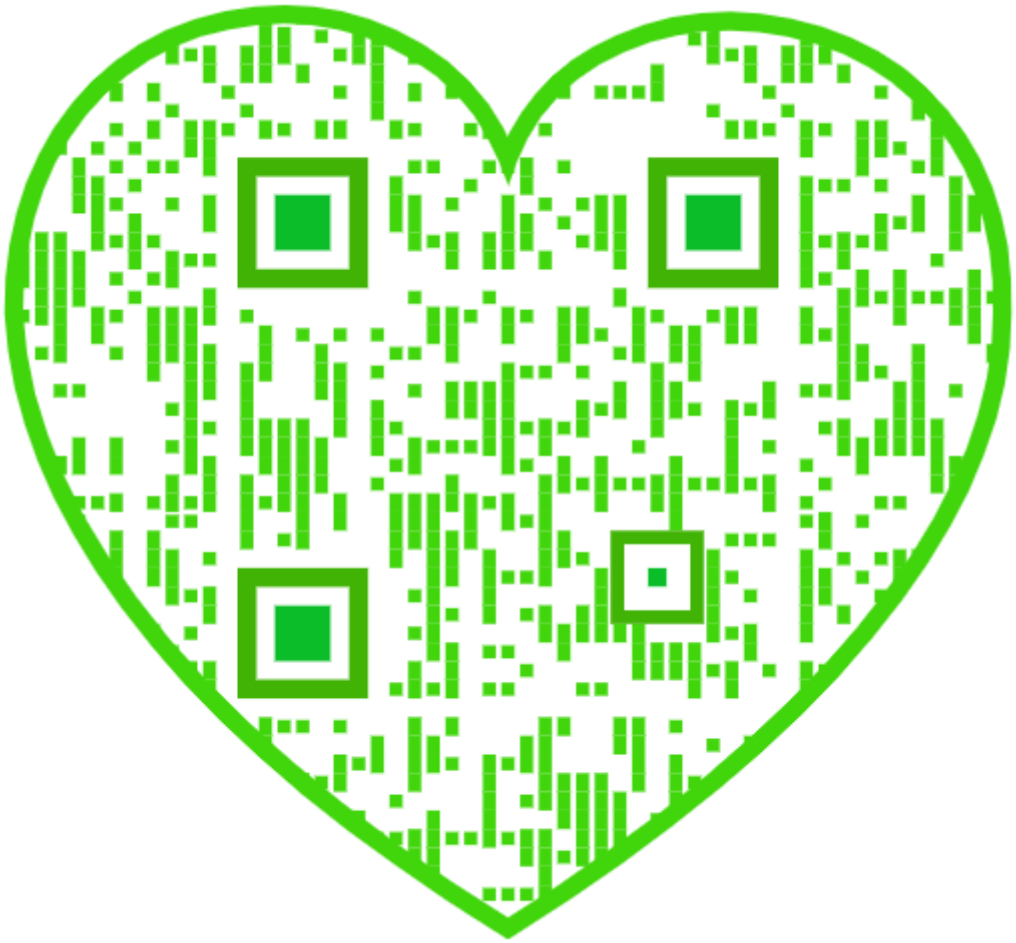

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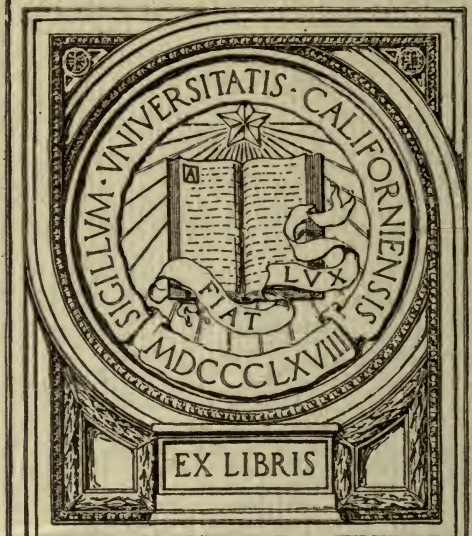
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LESSON PLANS

IN

ARITHMETIC

ALVA W. STAMPER

State Normal School, Chico, California Publications

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LESSON PLANS IN ARITHMETIC

BY

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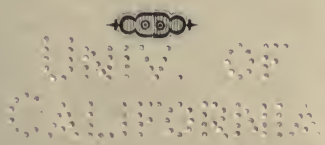

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LESSON PLANS

Every teacher, every day, should plan her lessons systematically, even if the work is mere drill, but she should always abandon any part of a plan when better methods suggest themselves during the progress of a lesson.

In presenting new work, inexperienced teachers are apt to overdevelop. Be wary of long tedious presentations of matter that is beyond the appreciation of young minds, especially in the lower grades. While it is necessary for the teacher to explain and develop new principles, it is more important to follow this up with sharp quick drills, for there is no surer way of finding out if principles are understood.

In developing a working principle or explaining a problem, resolve the same into a series of steps and make sure that the class can do the same.

The following plan, which may be used in presenting new work in any of the school subjects, lends itself readily to preparatory lessons in arithmetic.

LESSON
(General Plan)

a. Unit of Instruction: This may be a topic with or without sub-topics.

b. Special Phase of this Unit: This may be a sub-topic or a special kind of problem.

c. Devices and Materials.

Method of Procedure

1. Aim. — As the lesson progresses, the class should clearly understand the ends sought. The aims, if there be more than one, may be distributed throughout the lesson, not always formally. Proper incentives given a class at the right time make toward good results.

2. Preparation. — Prepare for the new by reviewing the features of the old that are to be used in the development.

3. Presentation. — Introduce the new subject-matter, relating it to the centers of association set up in (2).

4. Generalization. — As a summation of the conclusions reached in (3), deduce the working principle or rule.

5. Application. — This tests the pupil's understanding of the principles stated in (4).

The last four of the five formal steps in the above plan can not be clearly defined in treating some topics. The arrangement given must be considered as elastic.

The aim of the teacher is usually different from the one given the class, being broader and sometimes extending through several lessons.

The following lesson plans are to be considered as suggestions. No two teachers can present any topic in the same way. Neither can one teacher easily duplicate any one of her own lessons as given. Much depends upon the treatment of the preceding material that forms a basis for the new topic. Teachers are naturally influenced in their methods of procedure by the texts they are using.

We precede each Lesson Plan by a brief summary of the review that bears on the new lesson. Some of this preliminary work may have been done weeks before in relation to other topics and some may have been recently developed as necessary steps leading to the new lesson. Inexperienced teachers, especially, should thus analyze the new work in relation to the old. They should also reduce the number of new things in any one lesson to a minimum.

Lesson I

Unit of Instruction: Notation and Numeration.

Special Phase of this Unit: Numbers of one, two, and three digits.

Devices and Materials.

Colored sticks or toothpicks. Rubber Bands. A box with three compartments to correspond to the units', tens', and hundreds' orders; numbers to be built on the box lid. In lieu of a box, a diagram may be drawn on a table.

Basis for the Lesson.

a. Ability to read numbers of one, two, and perhaps three digits.
b. Ability to write the same.
c. Ability to assign number values to groups of objects.

Method of Procedure

1. Pupil's Aim.

We wish to learn more about the reading and writing of numbers so as to understand how to add long columns. We will first build some numbers out of sticks.

2. Preparation.

If necessary review (a), (b,) (c) above.

3. Presentation.

a. Build numbers on lid of numeration box. Begin with loose sticks in units' box, the other boxes being empty. Have a pupil count out 17 sticks. Place band around 10 of them. Build the number. Build 26, 34, etc., and have them read.

Write these numbers on the board as they are built.

Teach names of units' and tens' orders.

b. Write 29, 37, etc. on the board. Have pupils read and build them.

c. Build, read, and write 124, 236, etc., thereby teaching hundreds' order.

d. Pupils write on the board numbers given by the teacher. Enumerate the orders.

4. Generalization.

As a result of the above development the pupils are to learn:

a. The names of the different orders.

b. Any order must contain no number greater than 9.

c. In a number like 326, the 2 represents two bundles or groups, ten units like those of the 6 in each bundle or group.

The 3 represents three bundles or groups, ten units like those of the 2 in each bundle or group. The 3 also represents three hundred of the units like those of the 6.

5. Application.

This has been partially given under Presentation. Since the pupils can probably already read and write numbers of three digits quite readily, there is no need of continuing this farther. Question them on the points emphasized under Generalization.

(Take up "carrying" in column addition in the next day's lesson as a farther application.)

Note: It may be possible to introduce thousands' order in the above lesson. In a later lesson the pupils should learn about the different periods.

Lesson II

Unit of Instruction: Subtraction.

Special Phase of the Unit: Use Addition Method where "carrying" is involved.

Basis for the Lesson.

a. Ability to make change by the making-up method, as commonly used in stores. Very simple examples requiring only mental work.

b. Ability to subtract in an example like $\begin{array}{r} 849 \\ \underline{217} \end{array}$, where the orders in the subtrahend are less than the corresponding orders in the minuend.

c. The habit of subtracting in an example like the above by

saying 7 and 2 are 9.

d. Ability to add columns involving "carrying."

Method of Procedure

1. Pupil's Aim.

How many can subtract 2013
1984 ?

We will now learn how to subtract such numbers.

2. Preparation.

a. A few written examples based on (c) and (d) above may be necessary.

b. Quick drill on some of the harder making-up combinations, especially those that will be used before the lesson is over. Thus: 9 and what are 17? 8 and what are 13? Etc.

3. Presentation.

Let us subtract 93
68.

Is this different from the examples we have been working?

How does it differ?

Does any number added to 8 give 3?

What is the first number larger than 8 that ends with a 3?

8 and what make 13?

Where do we write the 5?

How many to carry? (Why do we say "carry?")

How many can tell to what figure in the second column we add the 1 carried? (Since the 93 is the sum of the 68 and the desired remainder, we must add the 1 to the 6.)

We then look at the 6 and think 7.

What do we next say?

What figure do we write to the left of the 5? The answer?

Erase the answer and repeat the subtraction.

Next erase the 93 and the line beneath the 68 and add 68 and 25, placing the sum above the 68.

Erase the 25 and repeat the subtraction.

Ex. Subtract 58 from 83.

4. Generalization.

a. If, as in the above example, the 8 is greater than the 3, we must think of 13 in the place of the 3. If a 2 were above the 8, think of a 12 in its place. Etc.

b. Add the 1 "to carry" to the next figure in the subtrahend to the left.

c. After each of these changes are made subtract as in previous work.

5. Application.

a. Write a list of examples on the board and see if the class can follow the directions given in (a) and (b) above, not necessarily writing down the answers at first.

Thus write 85

27. The pupils say: "Think of 15 in the place of 5. Add 1 to 2, thinking 3 in the place of 2".

b. Now give examples for subtraction, requiring statements like the above in each step of the process.

c. Subtract numbers of three or more digits each.

Lesson III

Unit of Instruction: Division of Common Fractions.

Special Phase of the Unit: The rule for inverting the divisor.

Basis for the Lesson.

a. Multiplication of fractions.

b. Division of fractions with unlike denominators by reducing to common denominators.

Method of Procedure

1. Pupil's Aim.

We wish to learn a shorter way of dividing fractions that have unlike denominators.

2. Preparation.

Give some examples as in (a) and (b) above.

Thus: Multiply $\frac{5}{8}$ by $\frac{1}{4}$. Divide $\frac{4}{5}$ by $\frac{3}{4}$.

3. Presentation.

a. Divide $\frac{3}{4}$ by $\frac{2}{3}$ just as we have been doing.

Thus $\frac{3}{4} \div \frac{2}{3} = \frac{9}{12} \div \frac{8}{12} = \frac{9}{8} = 1\frac{1}{8}$.

Therefore $\frac{3}{4} \div \frac{2}{3} = 1\frac{1}{8}$.

b. Work this example in multipication: Multiply $\frac{3}{4}$ by $\frac{3}{2}$. We get $\frac{3}{4} \times \frac{3}{2} = \frac{9}{8} = 1\frac{1}{8}$. Therefore $\frac{3}{4} \times \frac{3}{2} = 1\frac{1}{8}$.

c. Since $\frac{3}{4}$ divided by $\frac{2}{3}$ gives $1\frac{1}{8}$ and since $\frac{3}{4}$ multiplied by $\frac{3}{2}$ gives the same answer, then $\frac{3}{4}$ divided by $\frac{2}{3}$ must equal $\frac{3}{4}$ multiplied by $\frac{3}{2}$, which is $\frac{2}{3}$ inverted.

d. Divide $\frac{1}{8}$ by $\frac{3}{4}$ by reducing to a common denominator. Multiply $\frac{1}{3}$ by $\frac{4}{3}$ and see if the answers agree.

4. Generalization.

Therefore, in order to divide a fraction (or whole number) by a fraction, multiply the dividend by the divisor inverted.

Thus: $\frac{3}{7} \div \frac{2}{3} = \frac{3}{7} \times \frac{3}{2} = \frac{9}{14}$. We do not need any longer to reduce fractions to common denominators when dividing.

5. Application.

a. Work examples of the above type.

b. And others where either dividend or divisor are mixed numbers.

c. Also choose the dividend a whole number.

Lesson IV

Unit of Instruction: Division of Decimals.

Special Phase of the Unit: The divisor a decimal.

Basis for the Lesson.

a. Division of integers, the quotient a decimal. Thus: Divide 135 by 25.

This necessitates the use of a point at the right of the dividend and the annexing of ciphers.

Also the proper placing of the first digit in the overhead quotient.

And the placing of the point in the quotient above the point at the right of the dividend.

b. Multiplying a number by 10, 100, etc. moves the point one, two, etc. places to the right.

c. Multiplying both divisor and dividend by the same number does not change the value of the quotient.

d. Multiplying the dividend multiplies the quotient, and multiplying the divisor divides the quotient.

Method of Procedure

1. Pupil's Aim.

Ex. If a boy earns $.65 a day, how many days will it take him to earn $7.80? In attempting to divide 7.80 by .65 the class sees the need of learning to divide by a decimal divisor.

2. Preparation.

Review such of (a), (b), (c) above as is necessary.

3. Presentation.

Ex. Divide 7.80 by .65.

How does this example differ from our previous examples in the division of decimals?

How can we make the divisor a whole number, keeping the same digits? (Multiply by 100.)

How would this affect the value of the quotient?

If we multiply the divisor by 100 so as to get a whole number as a divisor, what else must we do so as not to get too small a quotient? (Multiply the dividend by 100.)

This leads to the statement that we first move the point in the divisor two places to the right so as to rid the divisor of decimals, and then move the point in the dividend the same number of places to the right. Two points indicate the new positions of the points as shown below. (A caret is perhaps better.)

```
      1 .
.65.. 7.80..
```

Next place the 1 of the quotient over the proper digit in the

dividend (the 8).

Write the next digit of the quotient over the 0 and place the point of the quotient above the new point in the dividend.

4. Generalization.

We proceed mechanically as follows:

a. Move the point in the divisor to the right so as to rid it of decimals.

b. Move the point in the dividend the same number of places to the right.

c. Place the first digit of the quotient as in ordinary division.

d. Place the point in the quotient over the new point in the dividend. In short division the quotient and its point may be written beneath the dividend.

5. Application.

a. Work other examples as above, where the quotient is a whole number.

b. Examples where the quotient is a decimal.

c. Examples where ciphers must be annexed to the right of the dividend to accommodate the moving of the point.

Lesson V

Unit of Instruction: Mensuration.

Special Phase of the Unit: The area of a rectangle.

Devices and Materials.

Drawing of rectangle on the board, divided as described below.

A rectangular board, say 4″ by 9″, marked into square inches. (This may be used in another lesson in finding the area of a parallelogram.)

Basis for the Lesson.

a. Names of common geometric figures and their chief characteristics, especially points of similarity and dissimilarity between the square and the rectangle.

b. Ability to construct squares and rectangles, using preferably the draughtman's triangles and the scale, or graduated rule.

Method of Procedure

1. Pupil's Aim.

How many of you have fathers that own farms? If each of your fathers were to sell his farm, how would he figure what it is worth to him? This leads to the question of area in general and that of a rectangle in particular.

2. Preparation.

Perhaps no special review is necessary, but (a) and (b) above should be understood.

3. Presentation.

Draw on the board a rectangle 8″ by 14″, the longer side or, base, being horizontal.

Mark the sides into divisions of 1″ each.

Draw a horizontal line 1″ above the base so as to form a strip 1″ wide and 14″ long.

Divide this strip into square inches.

How many square inches in this strip?

How many strips like this could we draw? Draw them, but no more squares.

How many square inches in 8 strips? Ans. 8×14 sq. in., or 132 sq. in.

Into how many square inches, then, may this rectangle be divided?

4. Generalization.

Let us erase all the lines drawn in our rectangle. Who can tell, without trying to picture the squares, how we get 132 as the number of square inches that make up the rectangle? [We multiply 14 by 8, or 8 by 14.]

How do we find the number of square inches in a rectangle 16″ by 20″?

Introduce the term "area."

Find the area of a rectangle, the lengths of whose sides are expressed in feet.

The following should be emphasized:

a. The length and breadth must be expressed in like units.

b. The unit of area depends upon the unit of length. (How?)

c. Use of term "dimensions."

d. The area of a rectangle is found by multiplying the number of units of length by the number of units of breadth. Or it is the product of the two dimensions of the rectangle.

e. The term "area" defines the number of square units in the figure.

[Do not say that the area is 5" times 4", for inches times inches cannot give square inches. The multiplier must always be abstract. Say 5 times 4 gives 20, the number of square inches.]

5. Application.

a. Give other examples involving different linear units, requiring only mechanical work.

b. Have a rectangle drawn and also its unit of area.

c. Find the area of the school-room floor, measuring its dimensions to the nearest foot and half foot.

Note: In the following lessons have plans of irregular figures drawn to scale, choosing figures that can be divided into rectangles. Compute perimeter and area. The ground plan of the school building may give suitable data.

Lesson VI

Unit of Instruction: Surveying.

Special Phase of the Unit: Heights.

Devices and Materials.

A measuring tape. A short stick or lead pencil.

Basis for the Lesson.

a. An understanding of the terms: Vertical line, perpendicular, horizontal line, right-angled triangle, parallel lines.

b. Ability to make drawings of the same.

c. Parallel lines are everywhere equidistant.

d. The proportions between corresponding sides in similar triangles. This is not necessary in case the teacher wishes to give these as rules in connection with the lesson, but it is necessary that the pupils be able to solve for x in proportions like $3 : 8 = 6 : x$.

Method of Procedure

1. Pupil's Aim.

How many have heard of lumbermen finding the height of trees when estimating timber? We shall learn to-day how to find certain heights without measuring them.

2. Preparation.

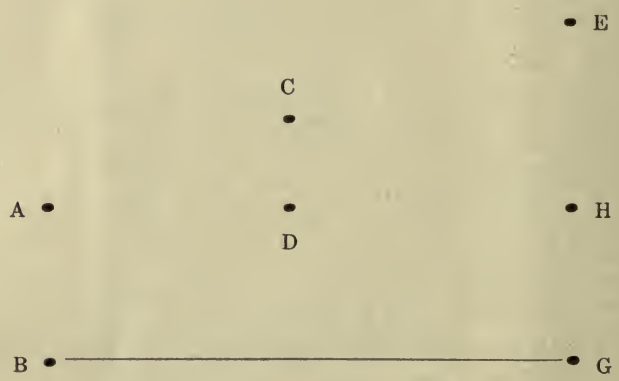
Review the terms given under (a) above and such of (d) as have been taught.

3. Presentation.

We wish to find the height of this room. (Specific aim.)

[As the measurements are taken let a drawing be made on the board, as nearly to scale as possible.]

We shall find the distance from a corner of the ceiling to the corresponding corner of the floor [the line joining the points represented by E and G] .



A pupil stands in the position AB, his eye at point A, and his arm extended so that when he sights over the top of the stick CD held vertically in his hand, he sees the corner of the ceiling [at E]. At the same time he sights under the lower end of the stick so that the line of sight, AH, is horizontal.

The stick CD has already been measured, and is 1 foot long. Measure AB (4′ 6″), the height of the pupil from his eye to the floor. Measure AD (2′), the distance from the eye to the bottom of the stick. Measure BG (28′), the distance from the feet of the pupil to the corner of the floor.

Why does AH equal BC?

Reach the conclusion that since CD is $\frac{1}{2}$ of AD, EH is $\frac{1}{2}$ of AH. Therefore EH = 14′.

How long is EG? EG = EH + HG = 14′ + 4′6″ = 18′ 6″.

Get the value of EH also from the proportion, AD : CD = AH : EH. Substituting the proper lengths, we get 2 : 1 = 28 : EH. Hence 2 EH = 28 and EH = 14.

4. Generalization.

a. We measure first the small stick that is held in the hand. Hold the stick in the position described above. Measure the distance from the eye to the bottom of the stick. Measure the distance from the point on the floor where the pupil stands to the point on the floor directly beneath the point whose height is to be found. Measure the height of the pupil from his eye to the floor.

b. See that the pupils can tell how to write the proportion as given under Presentation, and that they can finally tell how to get the required height.

5. Application.

a. Substitute values in another drawing on the board to test (b) above.

b. Find another height to test (a) and (b) in Generalization either in this lesson or the next.

c. Have the class draw to scale the figure represented under Presentation for home work.

Note: CD and AD in the above figure may be in inches and

BG [or AH] in feet.

It is not necessary that the bottom of the stick or pencil be held on a level with the eye, but if done a little complexity is avoided.

The use of the 45° right triangle provides an easy method of finding heights.

Lesson VII

Unit of Instruction: Keeping Accounts.

Special Phase of the Unit: First lesson in keeping a personal cash account.

Materials.

A small cash book, about 3½" by 6". The right side of each page should have lines for double columns of figures.

A ruler. Black and red ink.

Basis for the Lesson.

a. Accuracy in column addition.

b. Ability to use the addition method of subtraction in writing down a missing addend in a column of figures whose sum is set down.

c. Multiplication of decimals as related to United States Money.

d. Possibly multiplication of easy common fractions.

Method of Procedure

1. Preparation.

a. On the day previous each pupil is asked to bring in a short list of amounts of money (real and imaginary) received by him on on specified dates, within the last week or month.

b. Also of amounts (real and imaginary) paid out by him on specified dates within the same period.

c. The aim is that the pupils learn how to keep their own personal accounts.

2. Presentation.

Let the children contribute as much as possible to the development of the lesson.

a. What title is to be written in the front of the book? (-----'s personal cash account.)

b. On which page of the open book do we write the list of expenditures? (The credit, the right-hand, side.)

Why do we credit cash that is paid out? Ans. Because the person paying the money must give himself credit for doing this, in his own cash account.

c. Why do we debit cash that is received? Ans. Because the person receiving the money is indebted that much to some one for rendering him that service.

d. Show where to write the year, the terms Dr. and Cr., and the items brought to class as assigned the previous day.

e. Write original entries in the first of the double columns on each page.

f. Write sub-totals, balances, totals, balances brought down, amounts carried forward, and amounts brought forward in the right-hand columns.

g. Plan to have balance made in the middle of the first page. Balance the account by the method suggested in [b] of "Basis for the Lesson" above.

h. Write other entries and write at the bottom of each page the amounts to be carried forward.

i. On top of the second open page write the amounts brought forward. Enter other items.

j. Rule all lines in red ink. Write balance in red ink, but not the balance brought down on the Dr. side.

3. Generalization.

This is largely provided for in the above. But emphasize especially:

a. The significance of debiting and crediting entries.

b. The object in balancing an account. The significance to be attached to the amount written on the Cr. side that balances the account.

4. Application.

Continue the work already begun.

Note: The double column page is not necessary, but its use is advisable.

In a later lesson teach the writing of receipts and receipted bills in relation to some of the entries.

Pupils may do a buying and selling business among themselves, using imitation money, and small printed cards to represent various kinds of merchandise. Such money and cards may be purchased from the publishing houses.

If any business is done on credit, open accounts with the proper persons, thus introducing the use of a ledger.

Lesson VIII

Unit of Instruction: Lending and Borrowing Money.

Special Phase of the Unit: Bonds.

Materials and Devices.

School, municipal, corporation, or United States bonds, if available. Otherwise a blank form or copy of a bond.

Basis for the Lesson.

Simple Interest. Promissory Notes. Ordinary applications in business arithmetic.

Method of Procedure

1. Pupil's Aim.

The teacher naturally tells the class that they are to learn something about bonds. A definite aim is developed in the Presention.

2. Preparation.

A preliminary review is perhaps unnecessary.

3. Presentation.

The city of Chico decided in 1902 to install a sewer system to

cost $45,000. No funds were available.

In what two ways could the money have been raised? Ans. By special tax and by borrowing.

It was decided to borrow the money.

When an individual borrows money, what must he give the lender? (A promissory note .)

Cities that borrow money also give that which is equivalent to notes, namely bonds.

The teacher will here bring out the points of similarity and dissimilarity between notes and bonds.

After the borrower determines the rate of interest he is willing to pay and at what intervals he wishes to pay back portions of the sum borrowed, he usually advertises the bonds "for sale." The highest bidder is the person who gives the borrower the greatest "bonus" for the privilege of lending him the money. This bonus, or gift, to the borrower is called the premium. The borrower issues as many bonds as there are times that he pays back portions of the principal. A bond is said to be redeemed when it is returned to the borrower on his paying the principal named in the bond together with the interest due.

4. Generalization.

a. The pupils learn that the bond has the function of a promissory note.

b. They learn how cities (and other corporations) borrow money and how the money is paid back.

c. They learn about paying premiums on bonds by the lender and why he does so.

5. Application.

Ex. The City of Chico, California, on January 1, 1902, issued bonds for $45,000 to provide funds for installing a sewer system. The bonds were forty in number and of equal face value. One bond was to be redeemed on January 1 of each year, beginning with January 1, 1903. Interest was to be at the rate of 5% per annum, payable semi-annually on January 1 and July 1 of each year. The bonds were sold at a premium of $1,100. Find the total amount that will have been paid by the city when all the bonds have been redeemed, and find the net cost to the city.

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